Space Weather Technical Forecast

Issued on Sunday, 11 August 2024 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-class flares expected with a chance of isolated X-class flares. Occasional G1-G2/Minor to Moderate geomagnetic storms likely with the potential for CME arrivals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with persistent high C-class activity and the largest flare a M5.3 originating from AR3780 at 10/0237UTC. There are nine sunspot regions visible on the disc. AR3780 remains very large, displaying a complex magnetic structure with a couple of weak delta spots, one to the north of the main spot and the other within penumbra to the south, this region has been re-classified as Fki/Beta-Gamma-Delta. All other regions appear generally stable with little growth observed in recent hours. AR3784 still appears to contain a delta spot configuration as it comes more into view.

Analysis of a CME produced in association with the M5.3 flare at 10/0237UTC suggest an Earth directed component with an arrival time at Earth for early Day 4 (13 Aug). No other significant CMEs observed in available imagery.

Solar Wind / Geomagnetic Activity: Slightly elevated solar wind conditions observed at L1 by DSCOVR/ACE through the first half of the period. A CME arrival was observed at approximately 10/1205UTC, with wind speeds falling to vary around 400-450km/s. Density remained at or below average throughout. The Interplanetary Magnetic Field, Bt, was generally weak to start, increasing to become moderate 8-12nT following CME arrival. The north-south component varied weakly, generally between -5nT and +7nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background below the S1 Minor Radiation Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 were predominantly at background levels. The 24-hour fluence was steady well below the Active threshold, with 1.64e6 integrated pfu observed at 11/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast, with further M-class flares expected and a slight chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: Continued impacts from one or more CMEs that left the Sun on the 7th are likely to begin the period. A further CME associated with the X1.3 flare on the 8th has the potential to arrive at Earth later Day 1 (11 Aug) though there is larger than usual uncertainty due to the challenging analysis and the exact arrival time is low confidence. Another CME in association with the M4.5 flare on the 9th produced a CME also forecast to have an Earth-directed component, with analysis suggesting an arrival early on Day 3 (13 Aug). This arrival may be coincident with a further CME which was observed in association with the M5.3 flare from the

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10th. The interaction of these two CMEs acting to lower confidence in arrival time significantly. CME influence is likely at times throughout the forecast period, however overall confidence in the CME forecast is low. Geomagnetic activity is expected to be mostly Quiet to Unsettled (Kp2-3), but with occasional G1-G2/Minor to Moderate Storming (Kp5-6) intervals likely in association with CME arrivals, and just a slight chance of G3/Strong (Kp7) storms. This risk decreases slightly going into Day 4 (14 Aug), but further CME influence remains possible.

Energetic Particles / Solar Radiation: A heightened risk of flare activity brings the slight chance of reaching/exceeding the S1 Minor Radiation storm level should any significant flares occur from active regions in the western hemisphere. The high energy electron flux is forecast to be at mostly background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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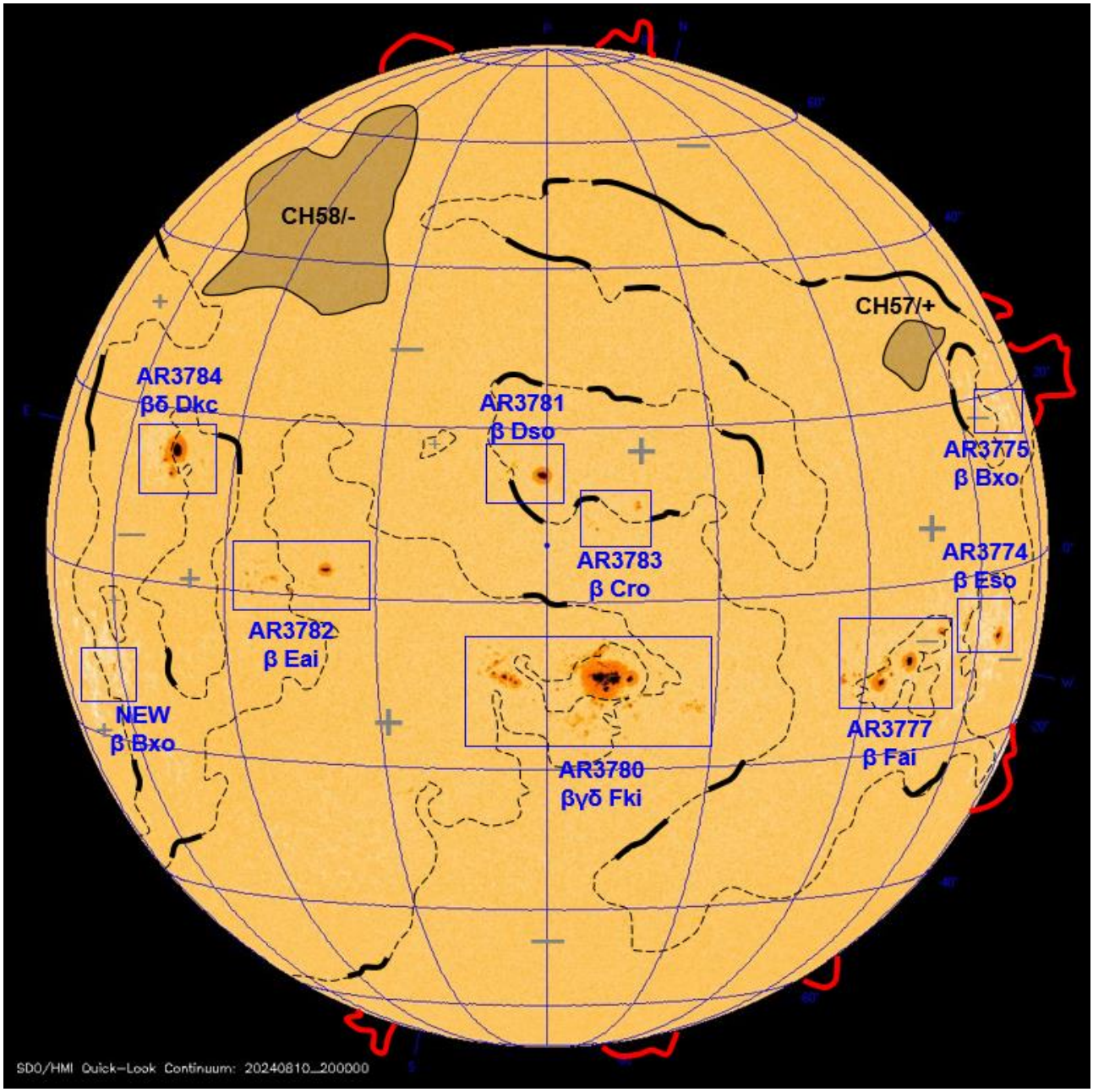
Figure 1. Solar Analysis Valid 10/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Continued impacts from one or more CMEs that left the Sun on 07 Aug are likely to begin the period. The X1.3 flare from AR3774 at 08/1935UTC produced a complex halo CME which has been analysed as having an Earth directed component. This CME has the potential to arrive at Earth later day 1 (11 Aug) though there is larger than usual uncertainty due to the challenging analysis and the exact arrival time is low confidence.

Another CME in association with the M4.5 flare from AR3777 at 09/2123UTC produced a partial halo CME alongside a Type II radio emission (estimated velocity 606km/s). This is also forecast with an Earth-directed component, with analysis suggesting an arrival early on Day 3 (13 Aug). This arrival may be coincident with a further partial halo CME which was observed in association with the M5.3 flare from AR3780 at 10/0237UTC. The interaction of these two CMEs acting to lower confidence in arrival time significantly.

Overall it is likely there will be some CME influence through much of the forecast period, though overall confidence in the forecast is low. Solar winds in ENLIL modeling are currently too high compared to actual values, and this will have some influence in determining arrival times of any CMEs.

Geomagnetic activity is expected to be mostly Quiet to Unsettled (Kp2-3), but with occasional G1-G2/Minor to Moderate Storming (Kp5-6) intervals likely in association with CME arrivals, and just a slight chance of G3/Strong (Kp7) storms. This risk decreases slightly going into Day 4 (14 Aug), but further CME influence remains possible.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	60	70	40
Strong	G3	No	15	5	10	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/0001	Full	X1.3	SW – AR3777	750 km/s	11/1600 UTC +8hr	Low confidence
09/2123	Partial	M4.5	SW – AR3777	633 km/s	13/0300 UTC +-8hr	Low confidence combined arrival
10/0645	Partial	M5.3	AR3780	750km/s	13/0300 UTC +-8hr	Low confidence combined arrival

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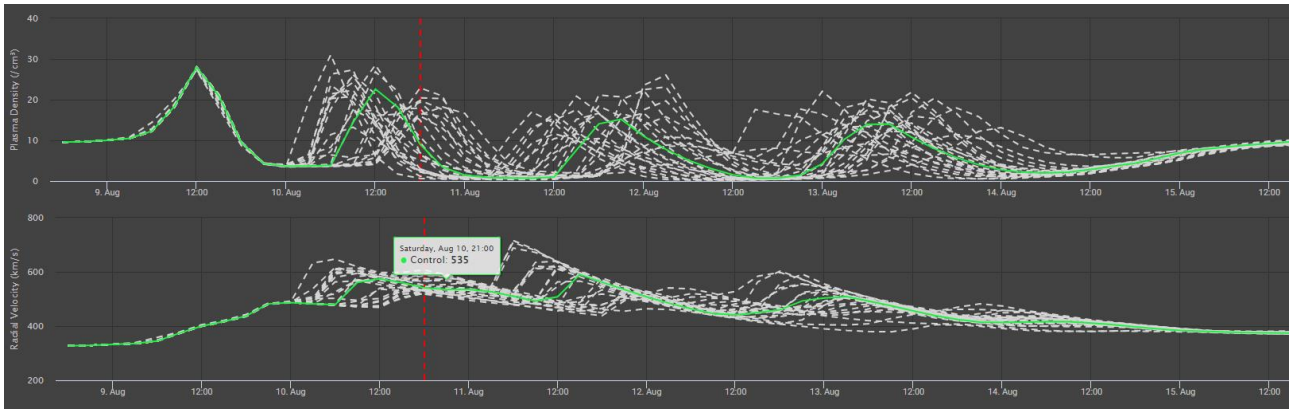
Figure 2: Latest MOSWOC ENLIL Ensemble output, showing potential for multiple arrivals through the period.



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Radio Blackouts - X-Ray Flares:
There are currently nine numbered sunspot regions on the disc, and one small region as yet unnumbered. AR3780 (Fki/beta-gamma-delta) remains by far the largest region on the disc and has produced the peak of recent M-class flare activity. AR3784 (Dkc/beta-delta) has also produced recent flare activity and remains a significant watch point given a compact and magnetically complex structure. We continue to see flare activity from the broad AR3777 (Fai/beta-gamma) region, and the increasingly departing AR3774 is also contributing to flare activity.

Overall further M-class flares are expected with a slight chance of an isolated X-class flare. The risk of flares reducing only slightly later into the period as we increasingly lose the influence of AR3774 and AR3777 pending further developments; with no significant oncoming regions currently expected.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	90	90	85	80
Very Active	R3 to R5 X Class	No	20	20	20	20

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Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18, was at background throughout the period. Any strong flares will bring the slight chance of reaching/exceeding the S1 Minor Radiation storm level, especially from AR3774 and AR3777 currently in the western hemisphere, and increasingly from AR3780 as it rotates into the western hemisphere later in the forecast period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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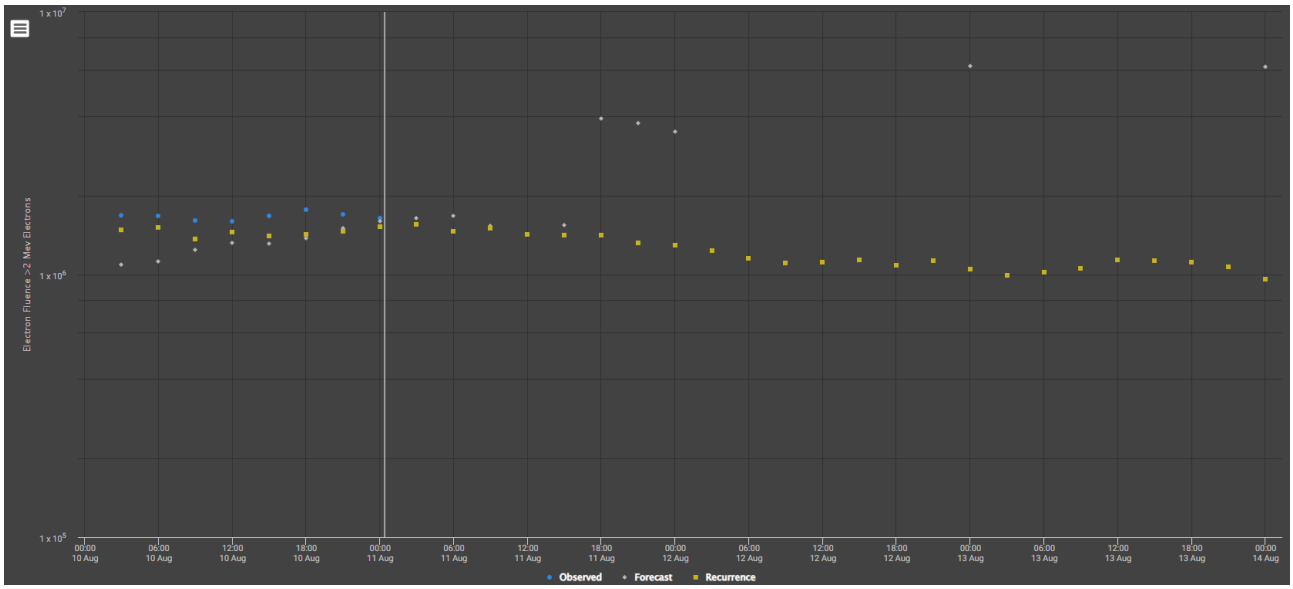
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16, is currently at background with the likelihood of further geomagnetic activity into period expected to keep observed values generally suppressed near background level. This is lower confidence however and any significant geomagnetic storming could also see electron flux at GEO increase to moderate or even high levels given the potential for electron transfer from currently more highly changed regions below GEO.

The associated 24hr electron fluence is therefore currently expected to remain below Active (1e8 integrated pfu) levels throughout but with reducing confidence into the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output.



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